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REPORT
ON
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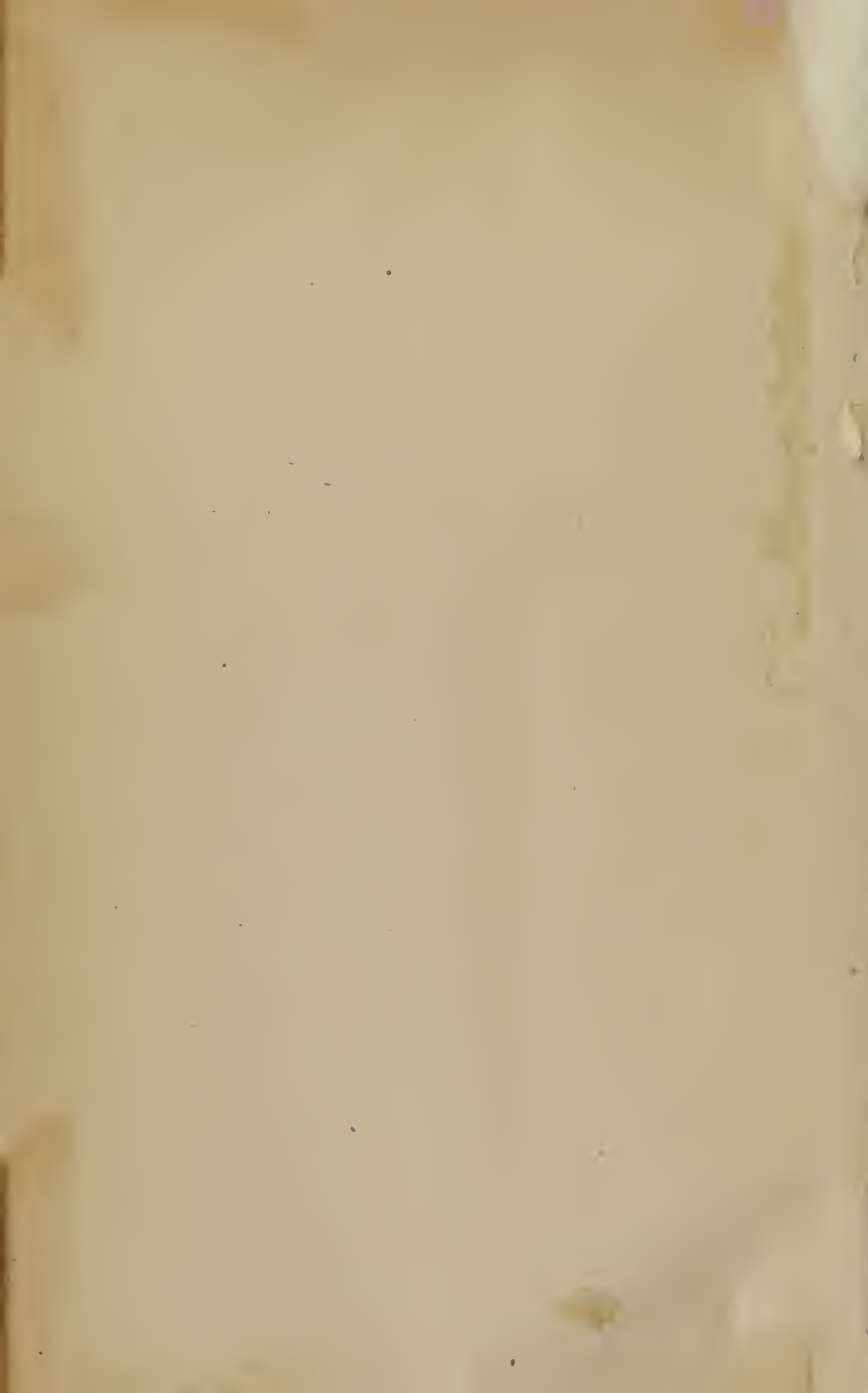
ITS PHYSIOLOGICAL PROPERTIES, AND CHEMICAL DETECTION.

BY
LEWIS H. STEINER, M.D.,
OF BALTIMORE, MARYLAND.

EXTRACTED FROM THE
TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION.

PHILADELPHIA:
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THE alkaloid Strychnia was discovered in the year 1818, by Pelletier and Caventou, of France. From that time down to the present it has attracted much attention, from the medical profession, on account of its peculiar action on the animal system, its employment as a remedial agent in certain forms of disease, and its occasional use as an efficient and certain poison by suicides. Much has been written on the subject, but not collected so as to form a connected account of its properties. Indeed our knowledge of the properties of Strychnia is, as yet, comparatively small, and it is only proposed to collect, in this paper, what may be relied upon as accurate and true so far as the physiological properties and chemical detection of this powerful alkaloid are at present known.

However admitted into the system, it acts by entering the circulation, and in this way is carried directly to the nervous centres, whence its peculiar effects are transmitted then to the muscular system. When injected in the veins it acts most promptly and energetically. This was fully established by Vernière, in the year 1827, as quoted by Pereira,¹ in an experiment showing that the blood acquired poisonous properties from its presence. Vernière states that, the extract of *nux vomica* being inserted in "the paw of an animal after a ligature had been tightened around the leg, so as to stop the venous, but not the arterial circulation of the limb, blood drawn from an orifice in a vein between the wound and ligature, and transfused into the vein of another animal, will excite in the latter the usual effects of the poison, so as even to cause death; while on the contrary, the animal from which the blood has been taken will not be affected at all, if a sufficient quantity is withdrawn before the removal of the ligature."

¹ Mat. Med., i. 153.

Since Vernière's experiments, however, others have been performed by distinguished physiologists in France, and its action on the system, in consequence of its admission into the circulation, seems no longer to allow of cavil. At one time, the doctrine of sympathetic nervous communication from the part with which it first came into contact to all other portions of the animal body, had gained considerable credence with the profession. The action was supposed to be somewhat like that of electricity on the vital economy; that as soon as the local effect was produced at one point, this constituted the centre from which irradiated general effects over the whole muscular system. Such an explanation was a mere crutch, seized by the physiologist to aid his tottering steps over difficulties, through which his knowledge did not enable him to pass safely. To be satisfied with this, would prevent that careful chemical examination that now enables the experimenter to detect the poisonous agent in the viscera, in so many cases, and by sure and reliable tests to prove its identity. Admit such a theory, and Flandin has truly said, "c'est déclarer le poison introuvable dans le corps de la victime." But the results of many examinations have shown, in the expert hands of various chemists, that it *can* be detected in *various* portions of the body after death, and thus is great probability conferred upon the theory of Vernière, that by means of the blood alone does it reach the great nervous centres, and its effects on these are then manifested by all the muscles which derive their nervous fibres directly from them.

Admitting that it enters the circulation, the question for our examination is, in what way does it produce its effects? Has Strychnia any property of *locally* affecting the organs of the body, or do not its effects proceed from some peculiar action it produces on the nervous centres? Ségalas¹ thought that it acted directly on the heart as well as on the nervous system, and endeavored to substantiate this by the fact, that "the heart of an animal poisoned by strychnia or brucia was insensible to the galvanic current." Flandin shows how the very fact that the blood is poisoned by strychnia would make it less fitted to preserve the movements of the heart, and that the destruction of its sensibility must necessarily result from the action of an agent that seemingly first excites the bodily functions and afterwards depresses them.

The effects produced by the action of strychnia manifestly pro-

¹ Flandin. Toxicologie, iii. 249.

ceed from its action on *the spinal column*; and this is not generally of such a nature as to exhibit any visible alteration even to the scrutinizing examination of the microscope. The muscular system is thrown into violent tetanic action, resulting in decided opisthotonos, and, notwithstanding this, the cerebrum seems but slightly affected, since the mind of the person, laboring under these violent convulsions, may be perfectly clear and undisturbed. His intellectual faculties will be unimpaired by the action of the strychnia, and rational answers will be quickly given in reply to all questions propounded to him. The effect must be slight on the cerebrum, and the whole force of the poison is expended on the medulla oblongata and the medulla spinalis. Magendie proved this years ago. An animal might be decapitated without preventing manifestations of tetanic action after strychnia had been taken, but the destruction of the spinal cord at once checked all manifestations of such action. We should go too far, however, if we were to conclude that there is no effect produced on the cerebrum by strychnia, since the organs of special sense become peculiarly sensitive. There is an exaltation of their powers. The eyelids are closed as though to shield the eyes from an intense glare of light; the ears become appreciative of the slightest sound that is made in the room; and occasionally cases occur where there will be loss of consciousness, as in the first one related by Orfila, where a young man having taken strychnia exhibited at times a perfect want of consciousness. *During* every violent paroxysm there will be a temporary loss of consciousness accompanied by a cessation of the act of respiration; the wide opening of the eyelids and extreme dilatation of the pupils. These symptoms are accompanied with what Orfila called a "véritable état de mort apparente avec les caractères de l'apoplexie portée au plus haut degré."

As another indication of the exaltation of the special senses, it may be mentioned that the sensation of touch is made painfully acute, and the slightest contact of a foreign body at once produces convulsions more or less powerful. The effort to raise the eyelid has produced a spasmodic action, which seemed to run through the whole system with electric rapidity. These facts, however, only show that while the powerful manifestations of its peculiar actions are shown in the derangement of the functions of the spinal column, yet the whole nervous system is at the same time more or less affected.

Authors have agreed that strychnia produces no changes in the

blood disks, and yet some change must be produced of an important character in the constitution of the blood. Magendie affirmed that there was perfect liquefaction of the blood after death by nitrate of strychnia. Orfila notices that on opening the vertebral column, "there ran out nearly 1 kilogramme of thick blood, very black, viscous, and non-coagulable, which stained the hands;" and that various plexuses of veins were *distended* with dark *liquid* blood. In the case of Dr. Gardiner, the anatomists reported that, "on removing the brain by the necessary division of the medulla spinalis, there was a very copious *flow* of highly carbonized blood from the base of the cranium and the spinal canal." Flandin states that the blood remained fluid in his experiments on animals poisoned by means of strychnia or brucia; and Blumhardt, in his published case, notices the same fact. Indeed, so frequently has this been observed, that we should be justified in expecting to see the blood in a liquid condition in every autopsy made of an individual destroyed by the action of strychnia. This blood has not thus far been examined by the microscope so as to refute or establish the opinion of Müller and Stannicus, with reference to the non-alteration of the blood disks. The liquidity may fairly be presumed to be similar to that found in cases of sudden death by electricity or other causes, acting on the body in full health.

The whole appearance of the body, on the minutest examination after death, fails to present changes adequate to the explanation of the violent symptoms. In this present condition of our knowledge, we are only able to sum up our acquaintance with the *modus operandi* in the few words, that strychnia acts by entering the circulation through absorption, exerts its influence most prominently on the spinal axis, and to a certain extent also, on all parts of the nervous system, and that animals destroyed by it do not exhibit lesions sufficient to account for the symptoms, although their veins are generally found engorged with dark liquid blood, viscid and non-coagulable.

The effects of this agent, when given in small doses repeated at regular intervals, are of a tonic character. For this reason it has been resorted to in certain forms of dyspepsia, especially where this is dependent on a want of tone in the stomach, and in pyrosis arising from mere "functional disorders of the stomach." Various authorities are cited by Pereira as supporting its use in cases where dysentery and gastrodynia have proven intractable to remedies. Its efficacy evidently depends on the gentle stimulus it gives to the

nervous system, which then in turn affords that necessary stimulus required by the muscles in order that their functions may be thoroughly performed. An experience of some years with the profession of this country and Europe seems to have approved and justified its use for this purpose.

Trousseau employed *nux vomica* in cases of impotence with considerable success, and though the effects were not permanent, yet its efficacy in temporarily removing the impotence was such that he continued to employ it for this purpose with both sexes. Where impotence exists from want of nervous energy, the strychnia appears to induce the necessary stimulation required by the organs of reproduction.

The second effect of strychnia is the production of a contracted state of the whole muscular system. The body assumes a tetanoid condition. There is a super-excitation of the nerves proceeding from the cerebro-spinal axis. We often have opportunities for witnessing this convulsive muscular movement, in cases of those who have been employing strychnia for the purpose of stimulation in "torpid or paralytic conditions of the motor or sensitive nerves of the muscular fibre." Increased sensibility of touch will be perceived. The contact of a slight breeze becomes painful, and that of a solid body produces shuddering and spasmodic movements. The gait is feeble and tottering, and a general tremor pervades the whole body on attempting to walk. Pereira speaks of being able often to recognize its effects on the muscular system, before the patient has noticed any peculiar symptoms, by tapping him suddenly on the ham which would induce a slight convulsive paroxysm. Such patients, when under the operation of this agent, undergo considerable mental agitation, at the appearance of these convulsive movements.

Closely following this condition of the system, is the commencement of convulsions without any adequate cause. The will seems to lose all command over the voluntary muscles, and the hands and legs move in spite of all determinations, on the part of the patient, against motion. There is an indisposition to voluntary motion of any kind, and rest on the back is generally preferred. Such an excitability of the spinal cord has been established, that the slightest impression from without, may be exaggerated by this excitable condition into a reflex action of a violent character.

The cerebrum, however, soon begins to evince some slight proof of the action of strychnia on it. There is an anxious expression

of the countenance, and general depression of spirits. The organs of special sense also become very acutely sensitive. But with all this excitement, the mind is able to think clearly and deduce conclusions from premises, with as much preciseness as at any other time. Indeed, in the case of Dr. Gardiner, which will be given in full, further on, there was the most decided manifestation of an intention to deceive, as to the substance taken for the purpose of destroying life; and to suggest another cause for the abnormal symptoms which presented themselves, and this was carried out even to the last paroxysm which closed his life, accompanied by repeated denials, that he was suffering any pain. The denial of sensation of pain was so opposed to the tetanoid condition of the body, that one could only conclude, that it proceeded from a fixed determination not to evince anything like complaint during the deadly action of the strychnia.

This *slight* action of strychnia on the cerebrum may, seemingly, be contradicted by certain post-mortems, which have revealed a ramollissement of the brain. But these cases have clearly shown that this ramollissement is the result of a species of inflammatory condition which the strychnia has established around some apoplectic clot, or deposit in the brain. The rule is, that the mind, during the influence of strychnia on the body, is clear and active.

With all the symptoms we have just described, no indication will be afforded by the arterial circulation that anything of a special character is producing secret, but powerful effects on the system. The pulse will scarcely be at all quickened—but will beat with about the same frequency it would exhibit were the individual in a deep and profound slumber. In Pierre Daste's case, quoted by Orfila, the pulse was said to present no remarkable alteration, and this is the statement with reference to nearly all the cases of which we have any published accounts. Occasionally, a slight reduction may be perceived in frequency and volume; but as a general thing no remarkable alteration of the arterial circulation will be exhibited.

The tetanic symptoms continue to come on with increased force, on the contact of any excitant, if the quantity taken has been sufficient, and at length the full effect of strychnia establishes full tetanus. At first there is a shuddering movement of the muscles, which increases until opisthotonos is produced. The back is strongly bent, so that the body is supported on the occiput and the heels, and the extensors of the lower extremities are thrown into a state

of rigid contraction. The arms become stiff, with the hands generally firmly clinched. The muscles of the chest and diaphragm are so strongly contracted, that air is prevented entering the lungs, the circulation is checked, the face becomes livid, or even of a black color, from the enormous engorgement of its vessels, and the lips are puffed out. The impression produced by these appearances is, as though the air were being driven through the mouth, on account of some enormous compression, applied to the diaphragm, operating upwards, and to the anterior walls of the chest, working backwards—and both uniting to express all the air that might be contained in the lungs. This condition may pass off, and all indications of tetanus disappear. If such an interval, as is most likely, occurs, there will be during its continuance no feeling of pain, no convulsive movement on contact with foreign bodies; but a general feeling of weakness and exhaustion will be experienced, inducing the individual to seek sleep. The thoughtless observer might conclude the danger was over. The calm, however, is deceptive. Soon the excitable condition of the system is again noticed—more sensitive indeed than before; all the organs of special sense become exceedingly acute. This state of things terminates in another violent tetanic spasm. The interval may be only from ten to fifteen minutes, or as long as an half hour; and the duration of the tetanic attack varies from one to three, or even five minutes. Each attack, however, leaves the sufferer more prostrated and exhausted than its predecessor, and finally death takes place during a paroxysm, or from extreme exhaustion. In the former case, the state of perfect asphyxia is induced. It is remarked by Carpenter,¹ of tetanus in general, and it is true of this particular form of that disease, that “the functions of the muscles controlling the various orifices, are those most affected; and it is by the spasm affecting the organs of respiration and deglutition, that life is commonly terminated.”

This range of symptoms, from slight tonic effects on the digestive organs, up to the powerful agitations produced by tetanus, is very extensive, and the whole are rarely seen in cases where strychnia has been employed as a poisonous agent, inasmuch as a sufficiently great quantity is generally taken, so as to bring on speedily the violent and peculiar effects which are comprised in the word tetanus.

It was denied for years, that strychnia could exhibit any cumu-

¹ Hum. Phys., 702.

lative effects on the animal system, but the case described by Mr. Cooper,¹ seems to show that such effects are exhibited by it occasionally. A Swede had been treated with strychnia for a species of general paralysis; one-eighth of a grain was given three times a day for several weeks; this was increased to one-fourth of a grain, and afterwards one half a grain was given with the same frequency for several days. But one morning he was found in a fit, insensible, his face and chest of a purple color. There was cessation of respiration and but feeble movement of the heart. All the indications of full tetanus had been produced. These passed off, and a short period of comparative freedom from pain then occurred, followed, however, by a still more violent paroxysm and death.

The diagnosis of a case of poisoning by strychnia,—its difference from a case of idiopathic tetanus is theoretically not very difficult to determine, but in practice, many difficulties present themselves. The symptoms necessarily come on more slowly in idiopathic tetanus than under the action of the poison, and in the latter case they can *generally* be traced as having some connection with articles of food or drink that have been taken. But if the person affected be disposed to deceive, there can be no assistance obtained in this way. In practice so far we have only been able to decide by antecedent and concomitant circumstances.

With reference to the treatment of cases where poisoning has been produced by strychnia, very little can be offered which may be considered as valuable by way of antidote. Lard has been proposed as an antidote, but there has been no definite conclusion arrived at as to its efficacy, and the opinion, based on experiment, is now that it is unreliable. The suggestion is due to Dr. Pindell, an American. It has attracted the attention of various toxicologists, and experiments have already been performed, and more doubtless will be undertaken, with the view of satisfactorily determining so important a matter. Camphor was announced as an absolute antidote, but experience has demonstrated its unfitness for such purpose. Conia, on account of its therapeutic properties being the opposite to those of strychnia, has however more claim on our attention. We doubt, however much may be said of these antidotes, whether it is possible to check the progress of the deadly effects of strychnia, when *it has once entered the circulation*; when it has once produced that change in the qualities of the blood which

¹ Pereira, Mat. Med., ii. 548.

cause it to engender such abnormal excitation of the nervous system. *Before* the strychnia has left the stomach, nothing could be more efficacious than an emetic, and therefore antidotes would be unnecessary. Judging from the case the writer had an opportunity of seeing, there seemed to be no hope after the full symptoms of tetanus were developed.

In order to exhibit the effects of strychnia on the system, or in other words, to show its toxicological effects, two cases are now given; that of Pierre Daste, as given by Prof. J. Cloquet, where the patient lived nearly three days; and that of Dr. Gardiner, who died within three hours and a half. They will exhibit the varieties of symptoms, which have been noticed in cases of poisoning, and will serve to substantiate the statements made in the first portion of this paper.

" Pierre Daste,¹ aged 45 years, of a bilious temperament, took at 9 o'clock in the evening of June 13, 1820, a considerable quantity of bruised nux vomica. Almost immediately after the ingestion of this poisonous substance, he was seized with violent convulsions. He was made to vomit by the administration of milk and warm water. At 10 o'clock, when removed to the Hôpital Saint Louis, his features were greatly altered. Convulsive paroxysms occurred at shortening intervals; their duration being from one to two minutes. They were marked by a rigorous stiffening of all the muscles; the trunk and limbs were violently extended, and the jaws were forcibly closed. The patient uttered broken shrieks and implored prompt relief. The pulse presented *no remarkable alteration*. During the night, *the senses of sight and hearing acquired exaggerated sensibility*. Such was the excitability of the muscles that it was only necessary to touch the patient in order to produce convulsive movements; and the slightest touch only was required to produce this effect. *During* the convulsions the pulse was frequent and agitated, and the patient was bathed in perspiration.

" On the 14th, at 7 A. M., the condition of the patient was more calm; the convulsive movements were less frequent, not so long, nor so violent. * * The pulse presented no febrile agitation. There was a general feeling of weariness and as though bruised over the whole body, but with no pain in the abdomen. At 9 A. M., the convulsive movements had ceased; the storm, so to speak, had disappeared, and everything seemed to foretell a happy termination.

¹ Orfila, Toxicologie, ii. 605; Flandin, iii. 201.

The insidious calm continued during the rest of the day and night.

"On the 15th, there was the same freedom from convulsions; with a sensation of feebleness and general languor. Some pain in epigastrium in the evening. Skin dry and pulse frequent.

"On the 16th, at 6 A. M., the pulse was small and almost imperceptible. There were dryness and heat of the skin, redness of the borders of the tongue, violent pain in the epigastric region, palpitations, dejection, extreme prostration, regularity of the intellectual functions, staring eyes, and altered features. Death occurred at 10 o'clock A. M. There was no stiffness of the limbs, and a viscid moisture covered the whole body.

"In the autopsy, 48 hours after death, no appreciable alteration was noticed in the meninges of the brain and the cerebral pulp. There were some adhesions between the pulmonary and costal pleuræ; lungs engorged with blood, principally at their base, which looked as though it were painted red. There was a violet color pervading nearly the whole skin, but the shade was more distinct in the lowest parts where the blood had collected on account of gravity." * *

Death seems to have occurred, in this case, *from the exhaustion produced by the previous convulsions*, and from which Daste did not rally.

The case of Gardiner shows more clearly and distinctly, than any other case which has thus far been presented to the notice of the profession, the legitimate effects of strychnia on a constitution in full health.

Dr. George A. Gardiner was convicted in Washington, on the 3d of March, 1853, of the charge of false swearing, after a protracted trial, and was immediately sentenced to the penitentiary of the District of Columbia for ten years. Shortly after the rendition of the verdict, he was observed to take some water from a glass. At this time, it is supposed that he slipped a small paper package, containing strychnia, in his mouth, and swallowed package and contents, as a paper wrapper was afterwards found in his stomach. This was probably about 12 o'clock M. From the court-room he was taken to the jail, and the Deputy Marshal states that he threw up the window, as Gardiner seemed to be suffering from heat, and gave him a glass of water, in accordance with a request made by him. Shortly after this, while attempting to raise a second glass to his mouth, he fell on the floor in a violent convulsion. The attendants raised him

from the floor and placed him on a cot which had been brought for the purpose. They spoke of noticing that "he was nervous."

The resident physician of the Washington Infirmary, Dr. Hellen, having been called in to see the case, the writer accompanied him; and from fifteen minutes before 1 o'clock until his death, the case was under his observation. Gardiner lay on the cot perfectly quiet at first; face somewhat flushed, pulse regular and about 90 to the minute. Upon inquiring whether he ever had suffered from an epileptic attack, his brother replied, "Yes, on several occasions," and that the first one was produced by a fall in a Mexican mine. On conversing with Dr. G., he objected to taking some brandy which had been sent for, and said, "Don't give me any stimulus," but consented that cold cloths might be applied to the forehead and temples. Twitchings of muscles began to present themselves, and spasmodic movements of the arms were occasionally observed. On his eyelids being touched, with the view of examining the pupil, a tolerably strong paroxysm was produced. His eyelids, it is proper to mention, were closed all the time, as though the light, which poured through the jail window, was intolerable. In fact the lids were only separated during the convulsions, and then the pupils were widely dilated. His hearing was very acute, and remarks made in a very low tone of voice were replied to quickly.

The extremities now began to move spasmodically, and the whole system seemed to be under the influence of a potent poison. A violent tetanic convulsion occurred, in which the body became quite rigid, the extremities violently extended, the hands firmly clinched, the lips puffed out, and frothy mucus protruded, driven out as it seemed by some enormous force which was producing the total expulsion of the air from the lungs; the hands were of a dark blue, nails blue, face livid, and features horribly distorted. The pulse was very feeble, and hardly perceptible. The convulsion soon passed off, with, however, no decided freedom from the tetanoid condition. Some relief seemed afforded by applications of strong mustard plasters to the ankles.

Dr. Hall arrived about 1½ o'clock P. M., and was with the patient until within a few minutes of his death, giving such medical directions as his own experience seemed to suggest. On asking Gardiner, through his brother, "whether he had taken any poison?" an emphatic "No!" was the answer. He also denied that he suffered any pain, and appeared resolutely determined to suppress anything resembling complaint. His mind was perfectly clear. There were

no indications of even the slightest derangement of his intellectual faculties. The convulsions affecting his arms were so frequent and repeated, that a person was on each side, holding his hands, at his request. It seemed that a mere touch was more of an excitant than a firm grasp of any part of the body. He called the writer, and said, with some emphasis: "If I die, I die innocent."

On endeavoring to remove his boots, so as to plunge his feet into hot water, violent convulsions were produced, and every indication of agony was manifest on his countenance. His limbs were so firmly and stiffly extended, that it was impossible to do more than semi-flex them, although the toes were somewhat limber. After the feet were in the water some five or six minutes, there was a relaxation of the spasms. But the tetanoid condition gradually came on again, and a most violent paroxysm ensued. There was considerable frothing at the mouth, complete opisthotonos, lividity of the face, entire cessation of respiration, and of the movements of the heart. He was thought dead for the moment by all around him. Gradually, however, the circulation seemed to be re-established, and the respiration to become easy and regular. As the convulsive movements ceased he became calm, and expressed a wish to be left alone, so that he might sleep. Soon, however, the tetanic symptoms again presented themselves, and another, though less violent, attack was experienced. He was much exhausted, as might have been expected, from the immense strain the muscular system had been subject to, but he continued to answer "No!" to the question whether he felt any pain. The strength of will, as exhibited in preventing the utterance of expressions of pain, was most remarkable, and probably has never been exceeded in the case of any suicide.

The physician to the jail, Dr. Semmes, arriving at 3 P. M., the case was placed under his charge. No peculiar symptom of interest was presented from that time up to twenty-five minutes past three, when he died. There would be slight intervals, lasting for a few minutes, of freedom from spasmodic action; and then a recurrence of spasm, until, finally, a violent convulsion ensued, in which the body became very rigid, the extremities violently extended, face livid, changing to a pale and somewhat bloodless hue, eyelids opened widely, and pupils dilated. The paroxysm was protracted longer than any of those preceding it. Exertions were made, in various ways, to re-establish the circulation, and overcome the spasm. All efforts, however, were in vain. Death ensued in some-

what less than three hours and a half after the poison had entered the stomach. An autopsy was held eighteen hours after death, and, from the notes of Drs. Miller, Semmes, and Stone, the following is extracted :—

“*External appearances of the body* rather emaciated. Face, neck, and back, livid; front of the body waxy and pallid; body extremely rigid; deep indentations on the right forearm, from the pressure of the indicator, medius, and thumb, of the opposite hand; articular abrasion of the left leg, in the anterior and internal tibial region, about five inches long by one and a half inches wide; fingers and thumbs were very livid, half-flexed, and slightly elastic.

“*The Head*.—Scalp much congested; the diploe congested, and a discharge of serum as soon as the saw had passed through the external table; meninges of the brain highly congested; the tissue of the brain and spinal marrow presented no abnormal appearances; the arachnoid a little milky in parts. A few minutes after removing the brain, by the necessary division of the medulla spinalis, there was a very copious flow of highly carbonized blood from the base of the cranium and the spinal canal. There was also a trace of a turgescence of the velum interpositum and choroid plexus, hardly worthy of notice. The investing membrane of the upper portion of the medulla spinalis, at its junction with the medulla oblongata, appeared to be slightly vascular.

“*The Thorax*.—Heart small, contracted, and contained no blood. Perfectly normal.”

The liver was normal and healthy in appearance, as also were the spleen and the pancreas. The kidneys were, however, highly congested.

On examining the clothing of the deceased, a white powder was found in one of the pockets. This was determined to contain commercial strychnia, or a mixture of strychnia and brucia. The qualitative analysis of the contents of the stomach, made by Dr. Breed, of the U. S. Patent Office, and the writer, furnished satisfactory evidences of the presence of strychnia, with some traces of brucia. There was also found in the stomach several pieces of paper, folded in the form employed by druggists for putting up powders, and comparing in size with the package found in the pocket of the deceased.

Comment is deemed unnecessary on this case, as every professional man will recognize at once the correctness of the verdict of the coroner's jury, that Dr. Gardiner came to his death by strychnia.

II. It is only proposed, in the second part of this paper, to notice the three different methods which have been proposed for the detection and determination of strychnia, when mingled with animal matter. Two of these only are strictly chemical, the third being based on its physiological properties. For a long time, it was believed to be impossible to separate organic alkaloids from animal mixtures without their unavoidable destruction by the heat to which it was thought necessary to subject them. This idea was dispelled when scientific toxicologists commenced examining carefully the processes which would be necessary to effect the elimination.

The difference in two of the processes depends on the method adopted for the purpose of removing the animal matter present. Orfila employed acetic acid. The suspected mixture was treated with acetic acid, filtered, and then evaporated to dryness. The residuum was drained with alcohol, and, after a second filtration, was evaporated and treated with the proper reagents; or it was again treated with acetic acid, and the acetate thus obtained was employed for the tests. It is evident that the alkaloid must be present in comparatively large quantity, in order to obtain the desired result. The process will answer if such be the case, and, in the examination of the contents of Gardiner's stomach by this method, there was no difficulty in obtaining satisfactory results. This process is, however, not the most delicate, and the alkaloid would be apt to escape detection were it present in very small quantity. It is necessary, then, to resort to the second process.

Orfila, in some of his experiments, employed animal charcoal as a decolorizer; and it is evident, from the peculiar properties of this substance as an absorbent of the alkaloids, that small quantities would be retained in the process of filtration, and thus the process itself would prevent the detection of the poison. Indeed, Orfila seemed to be conscious of the want of delicacy in his process, since he says,¹ "one should be circumspect when he pronounces on a case of poisoning by this alkaloid, and great account should be made of the *symptoms* which were experienced by the person."

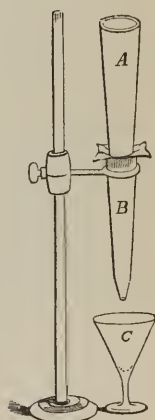
The simplest process, and, at the same time, that which is most reliable, is Flandin's (*Toxicologie*, par C. Flandin, iii. 254). He availed himself of the fact that a temperature of 100° C., will not affect the chemical constitution of strychnia, although it will render all the animal albuminous matters present in the mixture insoluble,

¹ Orfila, *Toxicol.*, ii. 595.

and will thus prevent them from interfering with the solutions we are hoping to make of the suspected strychnia. The addition of caustic baryta or lime to the animal material, will then cause the conversion of this into other compounds, and into soluble and insoluble soaps. All that would be necessary after the employment of the caustic alkaline earth, would be to employ a proper solvent for the alkaloid.

The process in the case of a suspicion of strychnia in animal matter, is as follows: the suspected organic matter is exsiccated in a water-bath, mixed with caustic lime (12 parts to 100), and well rubbed together in a mortar. This mixture is exposed in a water-bath, and the whole is subjected to the action of heat until it is reduced to a pulverizable form, which is then removed, and, after being reduced to a fine powder, is three times heated along with boiling alcohol, and subjected to filtration after it has become cold, when it will be found almost colorless. Now it is evaporated, and the residuum is treated with ether, to remove the fatty matter; this solvent is employed, since the alkaloid and its almost constant associate, brucia, are insoluble in ether. After the removal of the clear ethereal solution, the alkaloids (if present) will be found in the filter either pure or mixed with foreign matters. In the latter case, it will be necessary to treat the solid residuum with acetic acid, dry over a water-bath, and dissolve out by means of water. The acetate of strychnia has its base precipitated on the addition of ammonia, and the precipitated base caught on the filter of Danger, will give the reactions marking the alkaloid. Danger's filter is composed of two tubes—A, the upper, is of a conical shape, and fits into B, which is of a little larger bore. A circular piece of moistened filtering paper is placed over B, and A is then fitted in, holding the filtering paper in its place. The liquid to be filtered is then poured into A, and the solid matter is deposited on the paper as the liquid passes through it in its passage to C.

The physiological method of detecting strychnia has been lately suggested by Dr. Marshall Hall,¹ of England; it consists in em-



¹ Chemist for March, 1856, p. 382.

ploying live frogs, which seem to be most readily excited by the influence of strychnia. Dr. H. found that in the course of two or three hours' immersion in any liquid containing strychnia, the animal would be seized with general spasms, accompanied by tetanoid rigidity. One-hundredth of a grain of the acetate was readily detected in one experiment, and in some others, the one-five-hundredth, and even the one-thousandth of a grain produced the specific effects.

Necessarily the successful application of this test would not *positively* prove the presence of strychnia, but would furnish strong probability of its presence. Where chemical tests, which are necessarily less delicate than this, fail, its employment would be exceedingly useful in a medico-legal point of view, as corroborative of an opinion based on the symptoms exhibited by the person antecedent to death. No positive evidence can be given by a chemist of the presence of any toxic agent, unless he has separated it in one of its definite forms. Such cases may occur where strychnia is present in exceedingly minute quantities, and this physiological test would then become desirable presumptive proof.

Dr. Hall suggests the employment of this test as follows: "In cases of suspected poison from strychnia, the contents of the stomach and intestines, and the contents of the heart, bloodvessels, &c., must be severally and carefully separated, and made to act on lively frogs just taken from the ponds or mud. I need scarcely say, that taken in winter, the frog will prove more strychnoscopic than in summer, in the early morning than in the evening."

This suggestion is a very ingenious one, and has the originality which marks all the suggestions of the distinguished English physiologist.

NOTE.—The following notice of the action of the characteristic tests for strychnia, on that substance and its associate, brucia, is extracted from a highly interesting paper on the subject of nux vomica and its constituents, by Dr. Hirzel, of Leipzig.

STRYCHNIA.

When rubbed with sulphuric acid containing one per cent. of nitric acid, and a small quantity of the binoxide of lead, or the binoxide of manganese, it first assumes a beautiful blue, then a violet, a red, and finally a yellow color. This is a reaction capable of detecting 1-1000th of a grain. (*Marchand.*)

With sulphuric acid to which a few drops of a concentrated solution of bichromate of potassa has been added, it gives the series of colors just mentioned, but in a still more distinct manner. (*Otto, Riegel.*)

Diluted sulphuric acid, added to a mixture of chlorate of potassa and strychnia, and then warmed, gives on evaporation, a peculiar crystallizable acid—Strychnic acid. (*Rousseau.*)

BRUCIA.

Rubbed with sulphuric acid and some of the binoxide of lead or mercury, there is formed a brown, amorphous substance, soluble in alcohol and of a bitter taste; and a blackish red substance insoluble in alcohol. (*Marchand.*)

A solution of brucia in sulphuric acid tolerably concentrated, mixed with a few drops of a solution of bichromate of potassa, becomes a pistachio-green, an active disengagement of gas taking place at the same time.

Dr. Day's Test.—The suspected powder is moistened with one drop of concentrated sulphuric acid, and then a drop of ferrocyanide of potassium is added, which will produce an intense *violet*, though there should be only 1-1000th of a grain present. This test is not interfered with as much as some others by the organic matter present.

